


**Pennsylvania's
ALTERNATIVE
Residential
Energy
Provisions**

2009





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2009



First Printing September 2009

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PREFACE

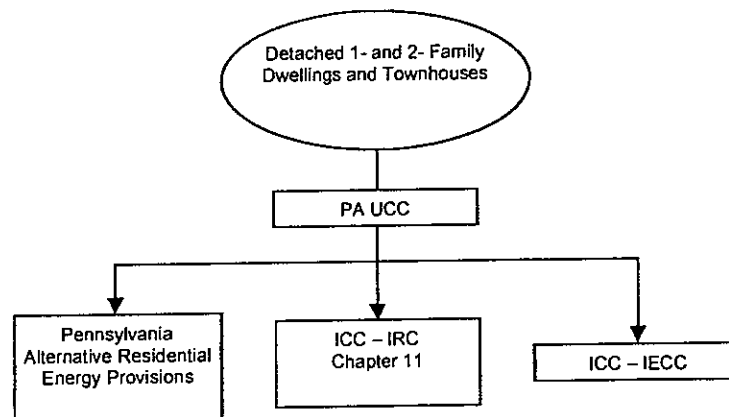
In November 1999, the Pennsylvania Legislature passed ACT 45, known as the Uniform Construction Code (UCC), into law mandating a statewide building code across Pennsylvania. Act 45 requires the Pennsylvania Department of Labor and Industry (DLI) to promulgate regulations to implement the requirements of the legislation and, in addition, to consider the development of alternative prescriptive methods for energy conservation that account for the various climatic regions within the Commonwealth. In deriving these energy standards, the DLI was to seek to balance energy savings with initial construction costs.

The PHRC developed *Pennsylvania Alternative Residential Energy Provisions* (PA-Alt) for consideration by DLI to meet their legislated mandate. The PA-Alt was developed with the intent of being:

- simpler to build to and easier to enforce;
- more rational and flexible;
- focused on Pennsylvania in terms of climatic and other conditions; and,
- equivalent to the provisions of the International Energy Conservation Code (IECC).

The initial version of the PA-Alt was developed in 2000 and was based on the 2000 IECC and IRC. The second and third versions were updated to the 2003 and 2006 IECC and IRC. This document is the fourth iteration of the PA-Alt and is equivalent to the 2009 IECC and IRC.

The *Pennsylvania Alternative Residential Energy Provisions* document is just that: an alternative to chapter 11 of the IRC. It is intended to supplement the IRC and, to the extent possible, to be consistent in format and general intent. The scope and definitions used in the IRC apply. The flowchart that follows illustrates how this proposed alternative path fits into the overall regulatory structure for Pennsylvania's UCC. It is important to note that a choice needs to be made by the builder or design professional between the PA-Alt, the IRC, and the IECC.



Flowchart Showing the Regulatory Paths for Space Conditioning Energy Compliance

The Development of the PA-Alt was led by the PHRC with guidance from an Advisory Committee. The PHRC would like to recognize the following members of the Advisory Committee for their contribution of time and knowledge:

Andy Bowman (Code Official)
Manheim Township Commissioners

Scott Cannon (Builder)
Cannon Custom Homes

Ed Carr (Energy Consultant)
Comfort Home Corporation

Don DeLess (Builder)
D&C Development Company

Jerry Leach (Builder)
Pennsylvania Builders Association

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Commonwealth Code Inspection Service

Mike Landis (Code Official)
Borough of Carlisle

Tim Palaski (Code Official)
Middle Department Inspection Agency, Inc.

Frank C. Thompson, (Builder)
Sweetwater Builders, Inc.

Financial support for work on the development of this document was provided by the Commonwealth of Pennsylvania and the Pennsylvania Department of Community and Economic Development through funds collected under Act 147 of 2007, the Hankin Endowment, the Pennsylvania State University and the members of the PHRC.

This document was developed by Mark Fortney, with assistance from Mike Turns, PHRC. Energy equivalence analysis was performed by Andy Lau, P.E., of the Center for Sustainability at the Pennsylvania State University. The document design and formatting was done by Rhonda Decker at the PHRC. The graphics were developed by Mark Martin.

The PA-Alt was developed by the PHRC as a service to DLI on behalf of all the consumers of housing in Pennsylvania.

Mark R. Fortney
Director

SECTION PA100
GENERAL

PA101 Scope. The provisions of this document regulate energy efficiency for the design and construction of buildings regulated by the 2009 International Residential Code in the Commonwealth of Pennsylvania.

Exception: Portions of the building envelope that do not enclose *conditioned space*.

PA102 Intent. This document was developed with the intent of being: simpler to build and easier to enforce; more rational and flexible; focused on Pennsylvania in terms of climatic and other conditions; and, equivalent to the provisions of the International Energy Conservation Code (IECC) in terms of energy efficiency.

PA103 Compliance. Compliance shall be demonstrated by either meeting the requirements of the *International Energy Conservation Code, the International Residential Code* or meeting the requirements of this document. Climate zones from PA201 shall be used in determining the applicable requirements from this document.

PA104 Entrance requirements. This compliance path allows for some reductions in energy efficiency that will allow simplified enforcement and construction. To provide for equivalent performance, the building owner or agent must choose one of the energy enhancements in Table PA104.

Table PA104
Energy Enhancement Options

| Option | Description | Minimum efficiency by climate zone | | |
|--------|--|------------------------------------|----------|----------|
| | | South | Central | North |
| 1 | Ductless systems ^a or all air ducts located inside the thermal envelope | | | |
| 2 | On-site electric generation installed ^b | | | |
| 3 | HERS Index of 85 or less ^c | | | |
| 4 | Geothermal or water source heat pump installed | | | |
| 5 | Solar hot water system installed ^d | 1.0 SEF | 1.1 SEF | 1.3 SEF |
| 6 | Improved efficiency air source heat pump installed | 8.1 HSPF | 8.8 HSPF | 9.5 HSPF |
| 7 | Improved efficiency furnace installed | 81 AFUE | 86 AFUE | 86 AFUE |

- Notes:
- a. Electric resistance heat is not allowed in this option.
 - b. This option is limited to systems of 1 kW or larger and include combined heat and power systems, fuel cell systems or photovoltaic solar systems.
 - c. HERS rating is required to be performed by Residential Energy Services Network (RESNET) Certified Rater and shall include plan review, inspections and post-construction testing. The RESNET-Certified Rater must certify to the building official that the building has a HERS Index of 85 or less and that it complies with the requirements of this document.
 - d. SEF is a certified performance rating of the solar water heating system determined in accordance with the Solar Rating and Certification Corporation's OG-300 Protocol. The collectors for the system must be mounted with a tilt from horizontal of no less than 15 degrees and no more than 45 degrees, and have an azimuthal orientation of within 45 degrees of true south.

PA105 Compliance documents. If this document is used for energy compliance it must be clearly identified on construction documents. Additionally, the option used to meet the entrance requirements in PA104 must be identified.

PA106 Definitions. To minimize confusion, the definitions contained in Chapter 2 of the IRC apply to this document.

PA107 Identification. Materials, systems and *equipment* shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this chapter.

PA108 Building thermal envelope insulation. An *R*-value identification *mark* shall be applied by the manufacturer to each piece of *building thermal envelope* insulation 12 inches (305 mm) or more wide. Alternately, the insulation installers shall provide a certification listing the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown or sprayed insulation (fiberglass and cellulose), the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be listed on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the area covered and *R*-value of installed thickness shall be listed on the certificate. The insulation installer shall sign, date and post the certificate in a conspicuous location on the job site.

PA108.1 Blown or sprayed roof/ceiling insulation. The thickness of blown in or sprayed roof/ceiling insulation (fiberglass or cellulose) shall be written in inches (mm) on markers that are installed at least one for every 300 ft² (28m²) throughout the *attic* space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers a minimum of 1 inch (25 mm) high. Each marker shall face the *attic* access opening. Spray polyurethane foam thickness and installed *R*-value shall be listed on the certificate provided by the insulation installer.

PA108.2 Insulation mark installation. Insulating materials shall be installed such that the manufacturer's *R*-value *mark* is readily observable upon inspection.

PA109 Fenestration product rating. *U*-factors of fenestration products (windows, doors and skylights) shall be determined in accordance with NFRC 100 by an accredited, independent laboratory, and *labeled* and certified by the manufacturer. Products lacking such a *labeled U*-factor shall be assigned a default *U*-factor from IRC Tables N1101.5(1) and N1101.5(2)

PA110 Insulation product rating. The thermal resistance (*R*-value) of insulation shall be determined in accordance with the CFR Title 16, Part 460, in units of h ft² °F/Btu at a mean temperature of 75°F (24°C), installer shall sign, date and post the certificate in a conspicuous location on the job site.

PA111 Installation. All materials, systems and *equipment* shall be installed in accordance with the manufacturer's installation instructions and the provisions of this code.

PA111.1 Protection of exposed foundation insulation. Insulation applied to the exterior of *basement* walls, crawl space walls, and the perimeter of slab-on-grade floors shall have a rigid, opaque and weather-resistant protective covering to prevent the degradation of the insulation's thermal performance. The protective covering shall cover the exposed exterior insulation and extend a minimum of 6 inches (152 mm) below *grade*.

PA112 Above code programs. The *building official* or other authority having *jurisdiction* shall be permitted to deem a national, state or local energy efficiency program to exceed the energy efficiency required by this document. Buildings *approved* in writing by such an energy efficiency program shall be considered in compliance with this document.

PA113 Certificate. A permanent certificate shall be posted on or in the electrical distribution panel. The certificate shall not cover or obstruct the visibility of the circuit directory *label*, service disconnect *label* or other required *labels*. The certificate shall be completed by the builder or registered *design professional*. The certificate shall list the predominant *R-values* of insulation installed in or on ceiling/roof, walls, foundation (slab, *basement wall*, crawlspace wall and/or floor) and ducts outside *conditioned spaces*; *U-factors* for fenestration; and the solar heat gain coefficient (SHGC) of fenestration. Where there is more than one value for each component, the certificate shall list the value covering the largest area.

The certificate shall list the types and efficiencies of heating, cooling and service water heating *equipment*. Where a gas-fired unvented room heater, electric furnace and/or baseboard electric heater is installed in the residence, the certificate shall list “gas-fired unvented room heater,” “electric furnace” or “baseboard electric heater,” as appropriate. An efficiency shall not be listed for gas-fired unvented room heaters, electric furnaces or electric baseboard heaters.

SECTION PA200 CLIMATE ZONES

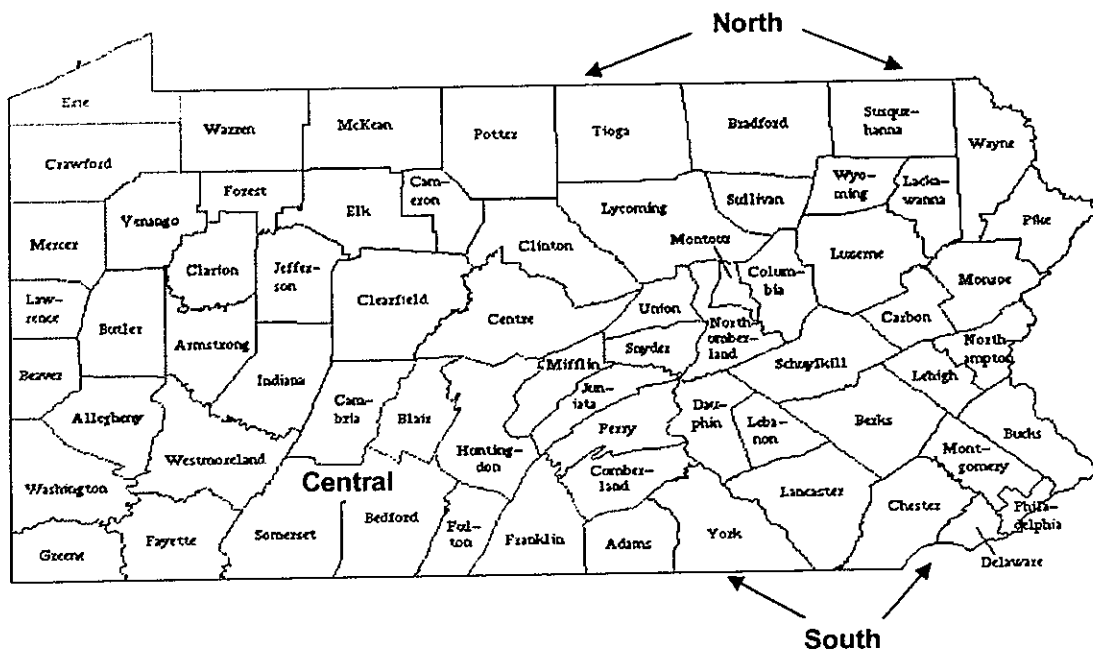
PA201 General. Climate zones listed in PA201.1 shall be used.

PA201.1 Climate Zones

South: Bucks, Chester, Delaware, Montgomery, Philadelphia, York

Central: All other counties

North: Cameron, Clearfield, Elk, McKean, Potter, Susquehanna, Tioga, Wayne



**Figure PA201.1
Pennsylvania Climate Zones**

SECTION PA300
BUILDING THERMAL ENVELOPE

PA301 Insulation and fenestration criteria. The *building thermal envelope* shall meet the requirements of Table PA301 based on the climate zone specified in PA201.

PA301.1 R-value computation. Insulation material used in layers, such as framing cavity insulation and insulating sheathing, shall be summed to compute the component R-value. The manufacturer's settled R-value shall be used for blown insulation. Computed R-values shall not include an R-value for other building materials or air films.

Table PA301
Insulation and Fenestration Requirements by Component ^a

| Climate Zone | Fenestration U-factor | Skylights ^b U-factor | Ceiling R-value | Wood frame wall R-value | Mass Wall R-value ^h | Floor R-value | Basement ^c wall R-value | Slab ^d R-value and depth | Crawlspace ^e wall R-value |
|--------------|-----------------------|---------------------------------|-----------------|--|--------------------------------|-----------------|------------------------------------|-------------------------------------|--------------------------------------|
| South | 0.35 | 0.60 | 38 | 13 | 5/10 | 19 | 10/13 | 10, 2 ft | 10/13 |
| Central | 0.35 | 0.60 | 38 | 20 ^f or 13 + 5 ^g | 13/17 | 30 ^f | 10/13 | 10, 2 ft | 10/13 |
| North | 0.35 | 0.60 | 49 | 20 ^f or 13 + 5 ^g | 15/19 | 30 ^f | 15/19 | 10, 4 ft | 10/13 |

- Notes:
- a. R-values are minimums. U-factors and solar heat gain coefficient (SHGC) are maximums. R-19 batts compressed in to nominal 2 x 6 framing cavity such that the R-value is reduced by R-1 or more shall be marked with the compressed batt R-value in addition to the full thickness R-value.
 - b. The fenestration U-factor column excludes skylights.
 - c. The first R-value applies to continuous insulation, the second to framing cavity insulation; either insulation meets the requirement.
 - d. R-5 shall be added to the required slab edge R-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less, in zones 1 through 3 for heated slabs.
 - e. Low density spray applied foam and cellulose insulation in a 2x6 wall cavity shall be considered in compliance with this requirement.
 - f. Or insulation sufficient to fill the framing cavity, R-19 minimum. Floor insulation may also be reduced to R-19 if installed above an unconditioned basement.
 - g. "13 + 5" means R-13 cavity insulation plus R-5 insulated sheathing. If structural sheathing covers 25% or less of the exterior, R-5 sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25% of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.
 - h. The second R-value applies when more than half the insulation is on the interior.

PA302 Specific insulation requirements.

PA302.1 Ceilings with attic spaces. When Section PA301 would require R-38 in the ceiling, R-30 shall be deemed to satisfy the requirement for R-38 wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Similarly R-38 shall be deemed to satisfy the requirement for R-49 wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves.

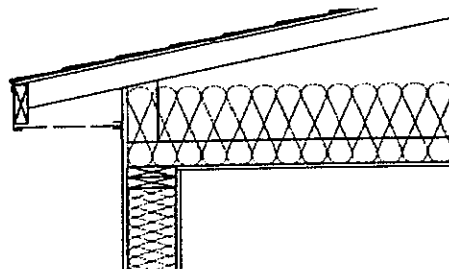


Figure PA 302.1
Ceiling Insulation With Full-Height
Uncompressed Insulation Above The Top Plate

PA302.2 Ceilings without attic spaces. Where the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, such as cathedral ceilings, the minimum required insulation for such roof/ceiling assemblies shall be R-30.

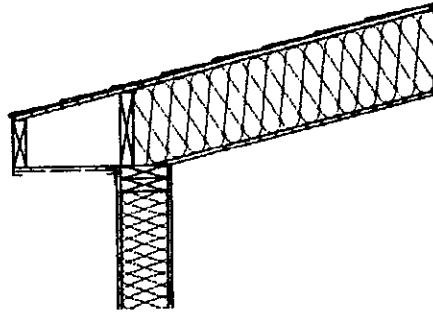


Figure PA 302.2
Ceiling Without Attic Spaces

PA302.3 Access hatches and doors. Access hatches and doors from *conditioned spaces* to unconditioned spaces (e.g., attics and crawl spaces) shall be weather stripped. Both vertical and horizontal access hatches shall be insulated to a minimum of R-20 with rigid foam permanently attached to the access hatch. This is not intended to restrict the use of proprietary products meeting the intent of this provision. Side hinged access door shall meet the fenestration requirements of Table PA301.

A wood framed or equivalent baffle or retainer is required to be provided when loose fill insulation is installed. The purpose of which is to prevent the loose fill insulation from spilling into the living space when the *attic* access is opened. Areas around access hatches required to service *equipment* shall provide a permanent means of maintaining the installed R-value of the insulation.

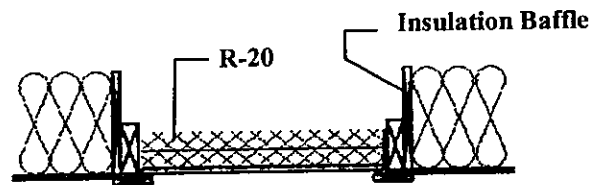


Figure PA 302.3 (1)
Attic Hatch

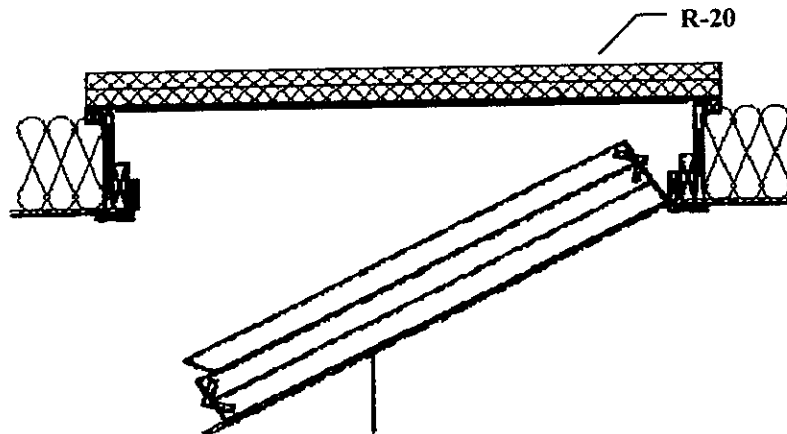


Figure PA 302.3 (2)
Pull-Down Stairs

PA302.4 Walls between conditioned and unconditioned spaces. Walls between conditioned and unconditioned spaces may be insulated to R-13. This includes walls between conditioned space and garages, and walls and ceilings of stairwells leading to unconditioned basements.

PA302.5 Mass walls. Mass walls, for the purposes of this chapter, shall be considered above-grade walls of concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth) and solid timber/logs.

PA302.6 Floors. Floor insulation shall be installed to maintain permanent contact with the underside of the subfloor decking.

PA302.7 Basement walls. *Exterior walls* associated with conditioned basements shall be insulated from the top of the *basement wall* down to 10 feet (3048 mm) below *grade* or to the *basement floor*, whichever is less. Walls associated with unconditioned basements shall meet this requirement unless the floor overhead is insulated in accordance with Sections PA301.

PA302.8 Slab-on-grade floors. Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table PA301. The insulation can be installed on either the exterior or interior of the foundation wall.

Exterior Insulation: Exterior insulation shall be installed from the top of the slab and extend below grade the distance listed in Table PA301 by any combination of vertical insulation or horizontal insulation extending away from the building. Insulation extending away from the building shall be protected by pavement or by a minimum of 10 inches (254 mm) of soil. Insulation shall also meet PA 111.1.

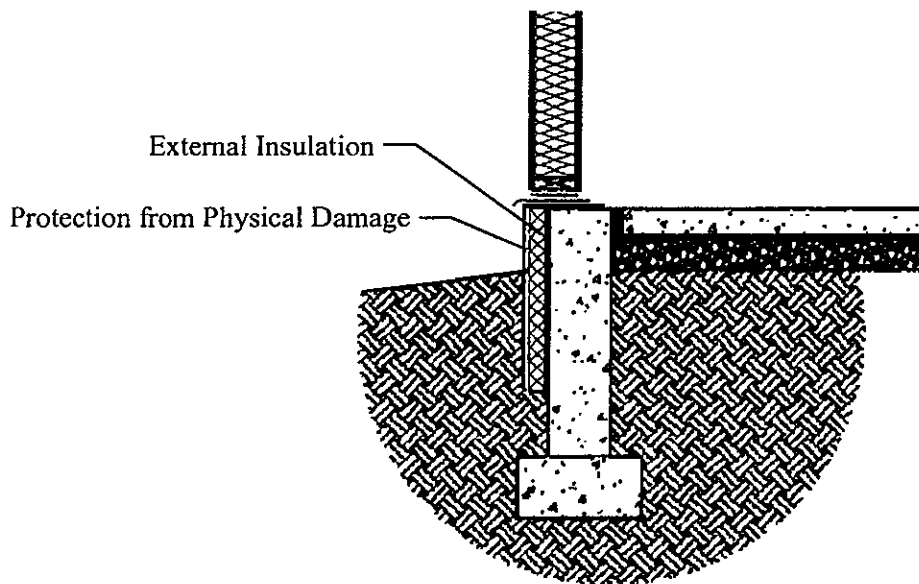


Figure PA 302.8 (1)
Exterior Slab Insulation

Interior Insulation: Interior insulation shall be installed from the bottom of the slab and extend the distance provided in Table PA301 by any combination of vertical insulation or horizontal insulation extending under the slab. The slab edge shall be separated from the foundation wall by a continuous ½ inch thermal break as per Figure PA302.8.(2) A thermal break shall be created by a material suitable for ground contact, which includes, but is not limited to, asphalt impregnated fiber board or extruded polystyrene. Slab-edge insulation is not required in jurisdictions designated by the code official as having a very heavy termite infestation.

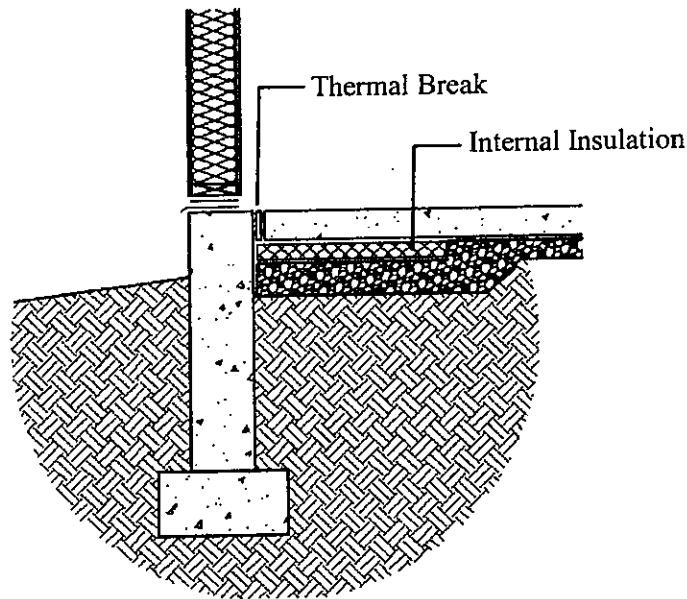


Figure PA 302.8 (2)
Interior Slab Insulation

PA302.9 Crawl space walls. As an alternative to insulating floors over crawl spaces, insulation of crawl space walls shall be permitted when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to the finished *grade* level and then vertically and/or horizontally for at least an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder. All joints of the vapor retarder shall overlap by 6 inches (152 mm) and be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches (152 mm) up the stem wall and shall be attached to the stem wall.

PA302.10 Masonry veneer. Insulation shall not be required on the horizontal portion of the foundation that supports a masonry veneer.

PA302.11 Thermally isolated sunroom insulation. The minimum ceiling insulation *R*-values shall be R-24. The minimum wall *R*-value shall be R-13. New wall(s) separating the sunroom from *conditioned space* shall meet the *building thermal envelope* requirements.

PA303 Fenestration.

PA303.1 U-factor. An area-weighted average of fenestration products shall be permitted to satisfy the *U*-factor requirements.

PA303.2 Glazed fenestration exemption. Up to 15 square feet (1.4 m²) of glazed fenestration per *dwelling unit* shall be permitted to be exempt from *U*-factor requirements Table PA301.

PA303.3 Opaque door exemption. One door assembly, including side hinged opaque doors, sidelights and transoms, up to 54 square feet (5.02 m²) in area is exempted from the *U*-factor requirement in Table PA301.

PA303.4 Thermally isolated sunroom *U*-factor. Maximum fenestration *U*-factor shall be 0.50 and the maximum skylight *U*-factor shall be 0.75. New windows and doors separating the sunroom from *conditioned space* shall meet the *building thermal envelope* requirements.

PA303.5 Replacement fenestration. Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for *U*-factor in Table PA301.

PA304 Air leakage.

PA304.1 Building thermal envelope. The *building thermal envelope* shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction. The following shall be caulked, gasketed, weatherstripped or otherwise sealed with an air barrier material, suitable film or solid material.

1. All joints, seams and penetrations.
2. Site-built windows, doors and skylights.
3. Openings between window and door assemblies and their respective jambs and framing.
4. Utility penetrations.
5. Dropped ceilings or chases adjacent to the thermal envelope.
6. Knee walls. (Fig. PA 304.1 (1))
7. Walls and ceilings separating the garage from *conditioned spaces*. (Fig. PA 304.1 (1))
8. Behind tubs, showers, and fireplaces on *exterior walls*. (Fig. PA 304.1 (2) and Fig. PA 304.1 (3))
9. Common walls between *dwelling units*.
10. Attic access openings.
11. Rim joists junction.
12. Other sources of infiltration.

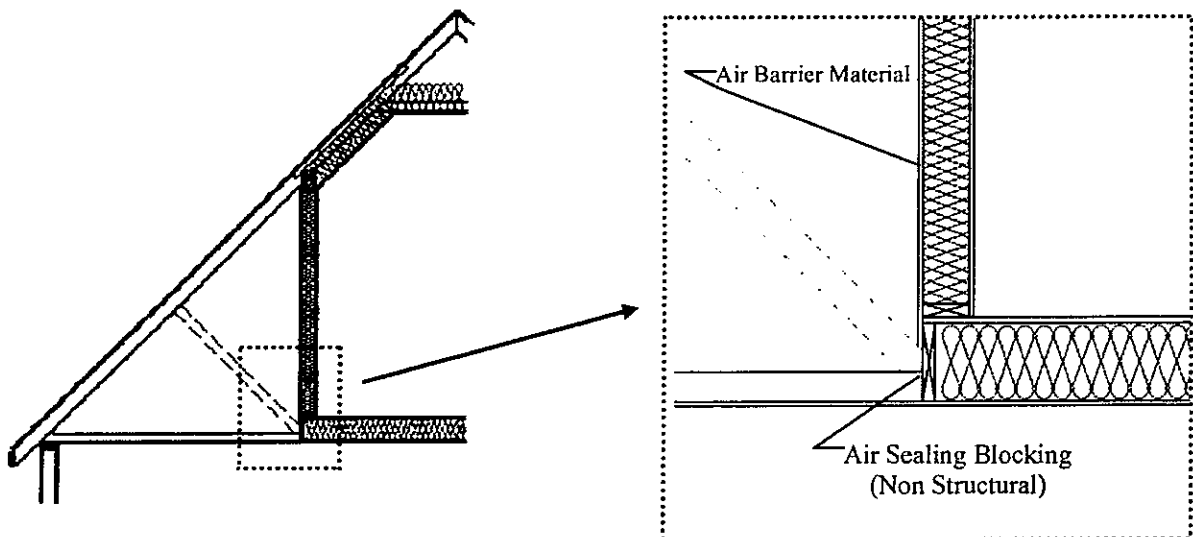


Figure PA 304.1 (1)
Air Sealing—Knee Walls

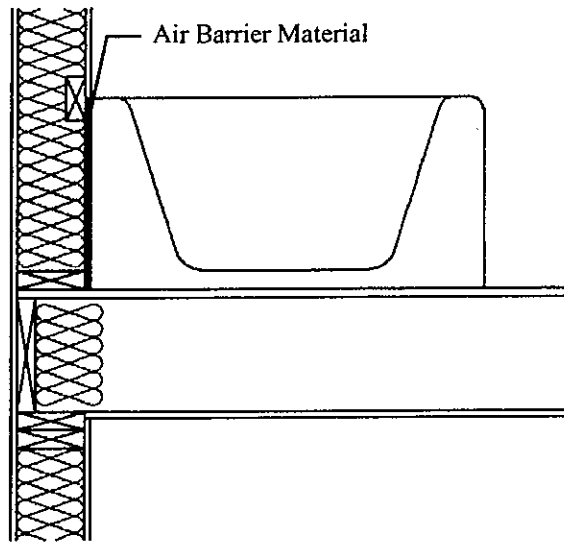


Figure PA 304.1 (2)
Air Sealing—Bathtubs and Showers

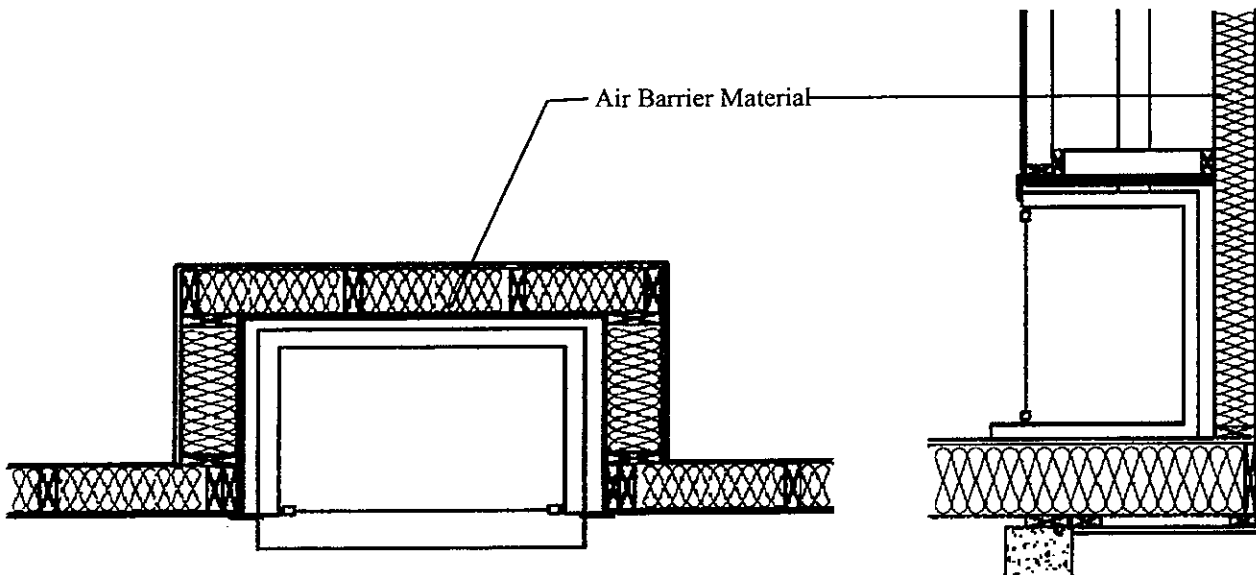


Figure PA 304.1 (3)
Air Sealing—Fireplaces

PA304.2 Air sealing and insulation. Building envelope air tightness and insulation installation shall be demonstrated to comply with one of the following options given by Section PA304.2.1 or PA304.2.2.

PA304.2.1 Testing option. Tested air leakage is less than 7 ACH when tested with a blower door at a pressure of 50 pascals (0.007 psi) in accordance with ASHRAE 119 Air Leakage Performance for Detached Single-Family Residential Buildings. Testing shall occur after rough in and after installation of penetrations of the building envelope, including penetrations for utilities, plumbing, electrical, ventilation and combustion appliances.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed;
2. Dampers shall be closed, but not sealed; including exhaust, intake, makeup air, back draft, and flue dampers;
3. Interior doors shall be open;
4. Exterior openings for continuous ventilation systems and heat recovery ventilators shall be closed and sealed;
5. Heating and cooling system(s) shall be turned off;
6. HVAC ducts shall not be sealed; and
7. Supply and return registers shall not be sealed.

PA304.2.2 Visual inspection option. The items listed in Table PA304.2.2, applicable to the method of construction, are field verified. Where required by the code official, an *approved* party independent from the installer of the insulation, shall inspect the air barrier and insulation.

PA304.3 Fireplaces. New wood-burning fireplaces shall have gasketed doors and outdoor combustion air.

Exception: Manufactured fireplaces where this requirement would void a product listing.

PA304.4 Fenestration air leakage. Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cubic foot per minute per square foot [$1.5(L/s)/m^2$], and swinging doors no more than 0.5 cubic foot per minute per square foot [$2.5(L/s)/m^2$], when tested according to NFRC400 or AAMA/WDMA/CSA101/I.S.2/ A440 by an accredited, independent laboratory, and listed and *labeled* by the manufacturer.

Exception: Site-built windows, skylights and doors.

PA304.5 Recessed lighting. Recessed luminaires installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and unconditioned spaces. All recessed luminaires shall be IC-rated and *labeled* as meeting ASTM E 283 when tested at 1.57 psi (75 Pa) pressure differential with no more than 2.0 cfm (0.944 L/s) of air movement from the *conditioned space* to the ceiling cavity. All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

**Table PA304.2.2
Air Barrier and Insulation Inspection**

| COMPONENT | CRITERIA |
|---|--|
| Air barrier and thermal envelope | Exterior thermal envelope insulation for framed walls is installed in substantial contact and continuous alignment with building envelope air barrier. Breaks or joints in the air barrier are filled or repaired. Air-permeable insulation is not used as a sealing material. |
| Ceiling/attic | Air barrier in any dropped ceiling/soffit is substantially aligned with insulation and any gaps are sealed. Attic access (except unvented attic), knee wall door, or drop down stair is sealed. |
| Walls | Corners and headers are insulated. Junction of foundation and sill plate is sealed. |
| Windows and doors | Space between window/door jambs and framing is sealed. |
| Rim joists | Rim joists are insulated and include an air barrier. |
| Floors (including above garage and cantilevered floors) | Insulation is installed to maintain permanent contact with underside of subfloor decking. Air barrier is installed at any exposed edge of floor. |
| Crawlspace walls | Insulation is permanently attached to walls. Exposed earth in unvented crawlspaces is covered with Class I vapor retarder with overlapping joints taped. |
| Shafts, penetrations | Duct shafts, utility penetrations, knee walls and flue shafts opening to exterior or unconditional space are sealed. |
| Narrow cavities | Batts in narrow cavities are cut to fit, or narrow cavities are filled by sprayed/blown insulation. |
| Garage separation | Air sealing is provided between the garage and conditioned spaces. |
| Recessed lighting | Recessed light fixtures are airtight, IC rated and sealed to drywall. Exception—fixtures in conditioned space. |
| Plumbing and wiring | Insulation is placed between outside and pipes. Batt insulation is cut to fit around wiring and plumbing, or sprayed/blown insulation extends behind piping and wiring. |
| Shower/tub on exterior wall | Showers and tubs on exterior walls have insulation and an air barrier separating them from the exterior wall. |
| Electrical/phone box on exterior wall | Air barrier extends behind boxes or air sealed type boxes are installed. |
| Common wall | Air barrier is installed in common wall between dwelling units. |
| HVAC register boots | HVAC register boots that penetrate the thermal envelope are sealed to subfloor or drywall. |
| Fireplace | Fireplace walls include an air barrier. |

SECTION PA400
SYSTEMS

PA401 Controls. At least one thermostat shall be installed for each separate heating and cooling system.

PA401.1 Programmable thermostat. Where the primary heating system is a forced air furnace, at least one thermostat per *dwelling unit* shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain zone temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed with a heating temperature set point no higher than 70°F (21°C) and a cooling temperature set point no lower than 78°F (26°C).

PA401.2 Heat pump supplementary heat. Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

PA402 Ducts.

PA402.1 Insulation. Supply ducts in attics shall be insulated to a minimum of R-8. All other ducts shall be insulated to a minimum of R-6.

Exception: Ducts or portions thereof located completely inside the *building thermal envelope*.

PA402.2 Sealing. Ducts, air handlers, filter boxes and building cavities used as ducts shall be sealed. Joints and seams shall comply with Section M1601.4. Duct tightness shall be verified by either of the following:

- Option 1. Post-construction test: Leakage to outdoors shall be less than or equal to 8 cfm (3.78 L/s) per 100 ft² (9.29 m²) of conditioned floor area or a total leakage less than or equal to 12 cfm (5.66 L/s) per 100 ft² (9.29 m²) of conditioned floor area when tested at a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler end closure. All register boots shall be taped or otherwise sealed during the test. Tests shall be conducted in accordance with ANSI/ASHRAE 152-2004, *Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems*.
- Option 2. Rough-in test: Total leakage shall be less than or equal to 6 cfm (2.83 L/s) per 100 ft² (9.29 m²) of conditioned floor area when tested at a pressure differential of 0.1 inch w.g. (25 Pa) across the roughed in system, including the manufacturer's air handler enclosure. All register boots shall be taped or otherwise sealed during the test. If the air handler is not installed at the time of the test, total leakage shall be less than or equal to 4 cfm (1.89 L/s) per 100 ft² (9.29 m²) of conditioned floor area. Tests shall be conducted in accordance with ANSI/ASHRAE 152-2004, *Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems*.

Exception: Duct tightness test is not required if the air handler and all ducts are located within *conditioned space*.

PA402.3 Building cavities. Building framing cavities shall not be used as supply ducts.

PA403 Mechanical system piping insulation. Mechanical system piping capable of carrying fluids above 105°F (40°C) or below 55°F (13°C) shall be insulated to a minimum of R-2.

PA404 Circulating hot water systems. All circulating service hot water piping shall be insulated to at least R-2. Circulating hot water systems shall include an automatic or *readily accessible* manual switch that can turn off the hot water circulating pump when the system is not in use.

PA405 Mechanical ventilation. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

PA406 Equipment sizing. Heating and cooling *equipment* shall be sized as specified in Section M1401.3.

PA407 Snow melt system controls. Snow- and ice-melting systems supplied through energy service to the building shall include automatic controls capable of shutting off the system when the pavement temperature is above 50°F (10°C) and no precipitation is falling and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F (5°C).

PA408 Pools. Pools shall be provided with energy conserving measures in accordance with Sections PA403.8.1 through PA403.8.3.

PA408.1 Pool heaters. All pool heaters shall be equipped with a *readily accessible* on-off switch to allow shutting off the heater without adjusting the thermostat setting. Pool heaters fired by natural gas or LPG shall not have continuously burning pilot lights.

PA408.2 Time switches. Time switches that can automatically turn off and on heaters and pumps according to a preset schedule shall be installed on swimming pool heaters and pumps.

Exceptions:

1. Where public health standards require 24-hour pump operation.
2. Where pumps are required to operate solar- and waste-heat-recovery pool heating systems.

PA408.3 Pool covers. Heated pools shall be equipped with a vapor retardant pool cover on or at the water surface. Pools heated to more than 90°F (32°C) shall have a pool cover with a minimum insulation value of R-12.

**SECTION PA500
LIGHTING SYSTEMS**

PA501 Lighting equipment. A minimum of 50 percent of the lamps in permanently installed lighting fixtures shall be *high-efficacy lamps*.